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(56) Documents Cited
GB 2316272 A GB 2298997 A GB 2288104 A
GB 2245455 A WO 95/24789 A2 US 5533114 A

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(54) Abstract Title
Local Routing in a Radio Communications System

(57) A radio communication system (100) comprises a plurality of mobile terminals (201) communicating with a plurality of base stations (203) over radio channels (205). Each base station (203) is connected to a base station controller unit (207), and each base station controller unit (207) is connected to a switch (209). The radio communication system further comprises at least one additional connection (401), a controller for detecting that a call can be routed along this connection and a controller for routing the call through the connection. The additional connection may be permanent or may be deployed dynamically in response to the traffic distribution. A more efficient, flexible and cost efficient routing in a radio communication system can be achieved by routing traffic through the additional connection directly between involved units rather than requiring the routing to be via the switch.

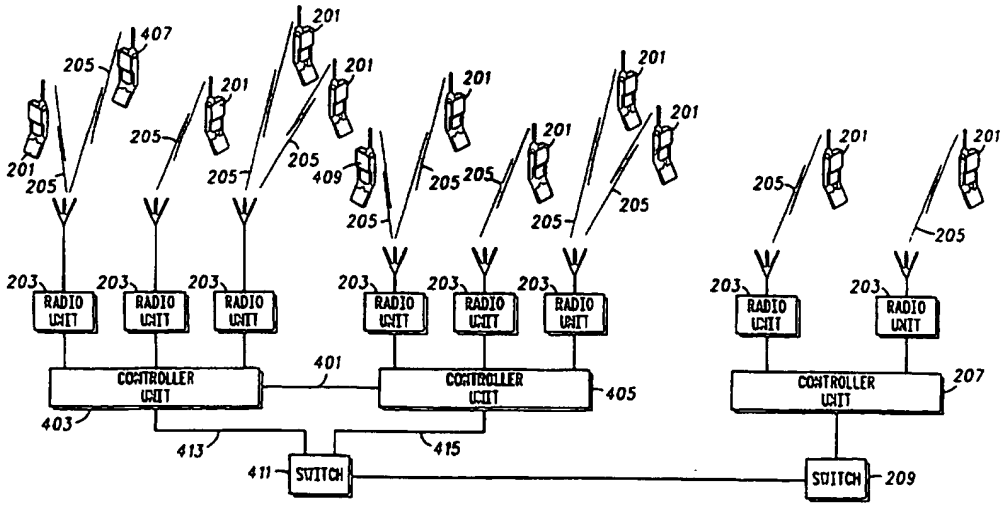
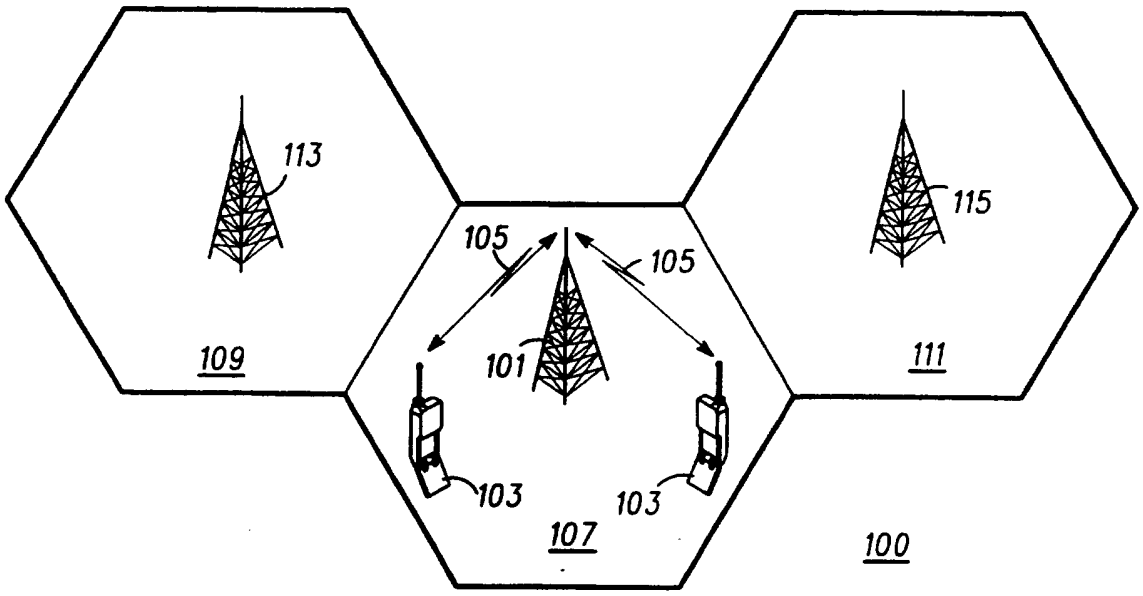


FIG. 4

GB 2 334 180 A

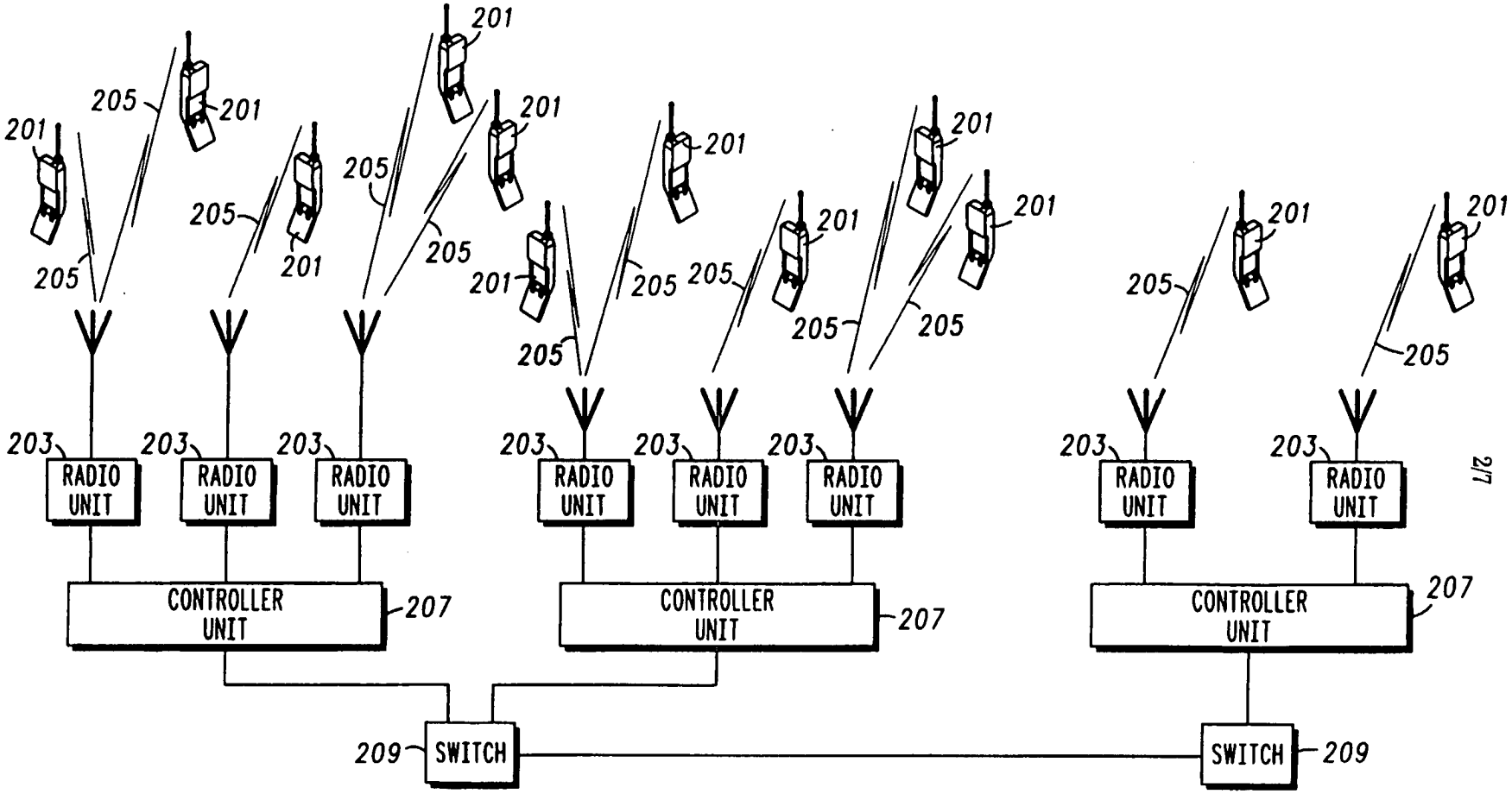
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.



100

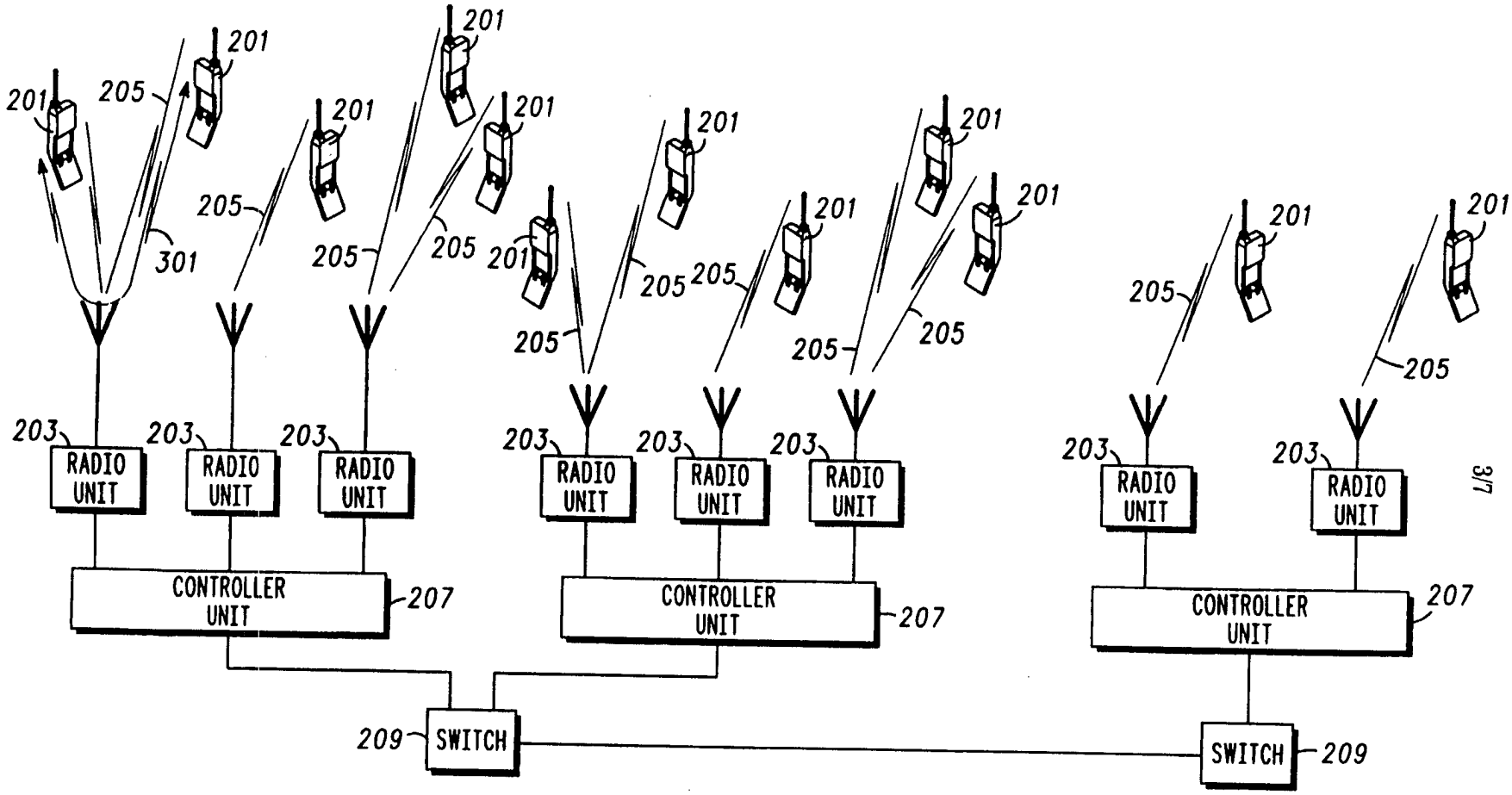
-PRIOR ART-

FIG. 1



200 -PRIOR ART-

FIG. 2



200 -PRIOR ART-

FIG. 3

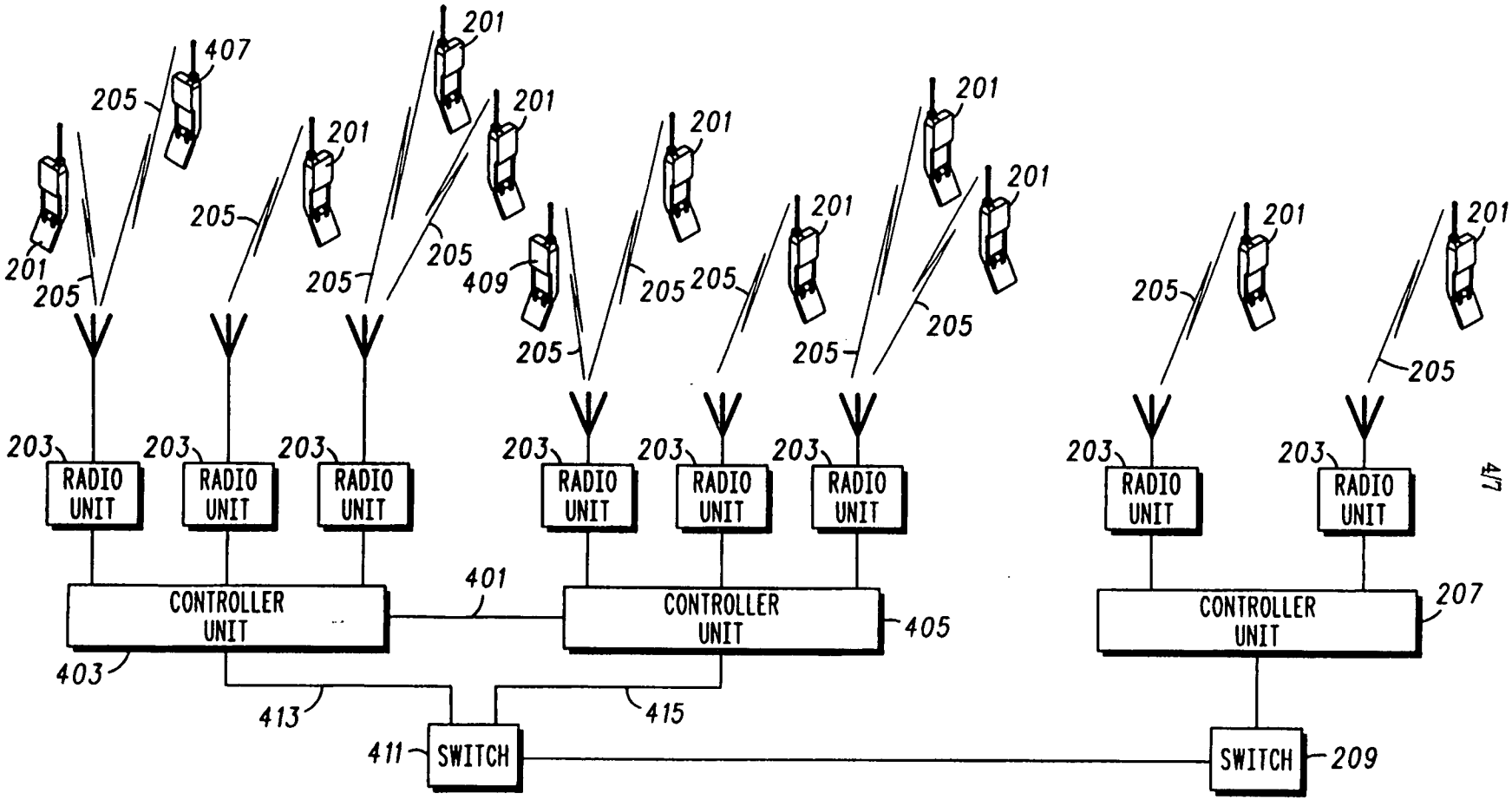


FIG. 4

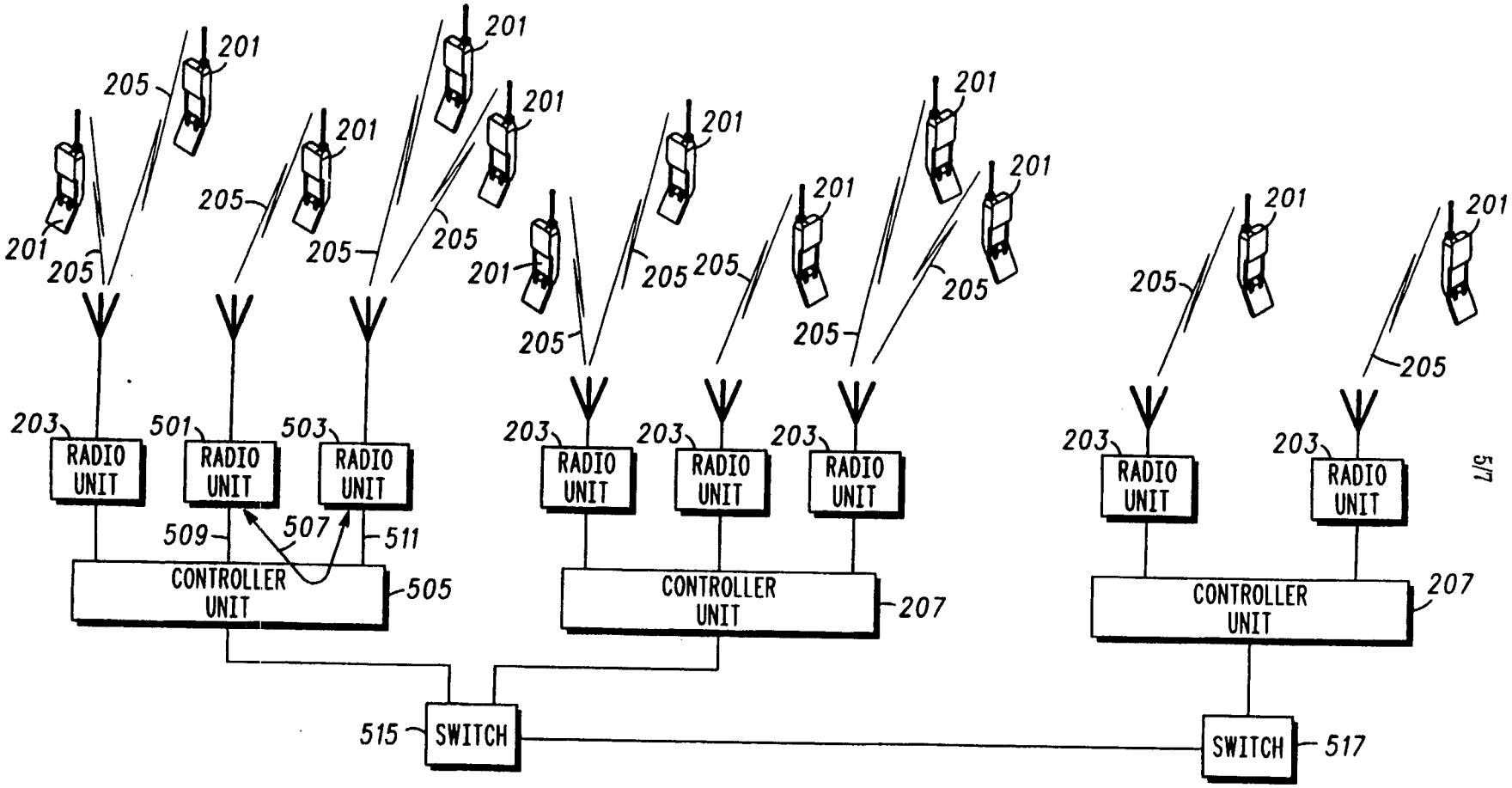


FIG. 5

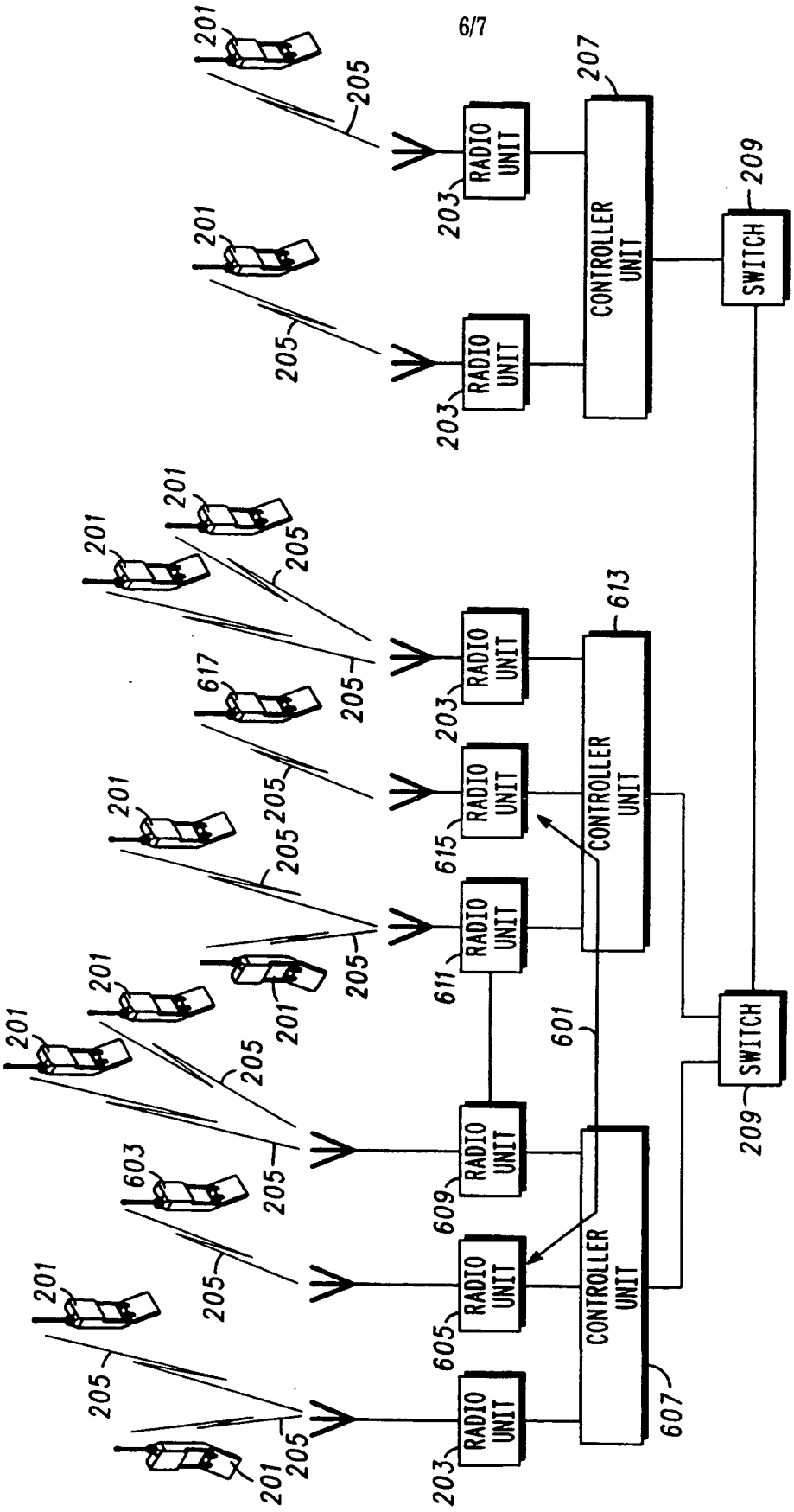
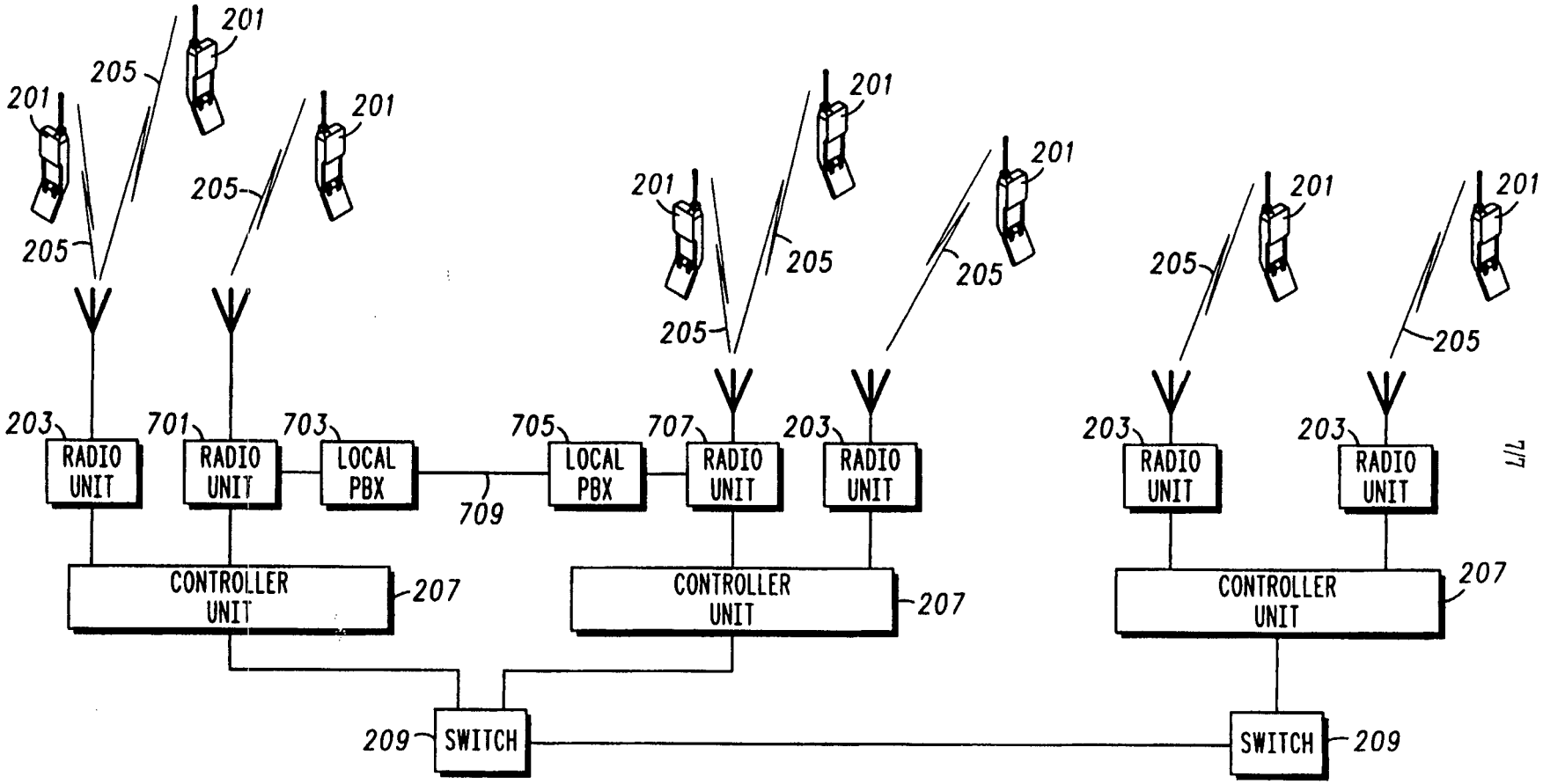


FIG. 6



200

FIG. 7

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RADIO COMMUNICATION SYSTEM WITH LOCAL ROUTING AND METHOD THEREFOR

Field of the Invention

This invention relates to a radio communication system incorporating an interconnecting network and a method of routing in such a network. The invention is applicable but not limited to the Global System for Mobile communication.

Background to the Invention

A number of radio systems exist where part of the connection between end users is over a radio channel and part of the connection is through an interconnecting network. A typical example is the Global System for Mobile communication (GSM) where the mobile terminals communicate with a central station over a radio channel.

In a call between two mobile terminals, the interconnecting network routes data between the two central stations associated with the two mobile terminals. A call between a mobile terminal and a fixed terminal connected to the public fixed line telephone system is routed through a point of interworking connecting the two systems. The interconnecting network comprises a number of base station controllers each of which may be connected with a number of central stations. The traffic data is routed from the central stations through the base station controllers to a master switch.

In the example of GSM, traffic data is routed from the central stations through the base station controller to the master switch. This results in very demanding requirements for the throughput capacity of the transmission links and the master switches. As a consequence, a high proportion of the cost of running a GSM network therefore results from the costs associated with the data transmission in the interconnecting network.

An earlier invention by Motorola has provided a system which, in the case of two mobile terminals having the same serving central station, allows the traffic data to be routed internally within the central station. This invention has been disclosed in British patent application number 9616794.5. The invention provides substantial benefits for calls between mobile terminals of the same central station but not for mobile terminals associated with different central stations.

The routing carried out by the interconnecting network in many radio communication systems such as GSM is thus highly inefficient and expensive and there is thus a desire for a more efficient and potentially cheaper system for routing data.

Summary of the Invention

This invention seeks to provide a more efficient and thereby cheaper routing of calls in a radio communication system by allowing additional connections between radio units and controller units to be utilised.

According to the invention, there is provided a radio communication system with a plurality of radio units for communication with mobile terminals, each radio unit connected to one out of a plurality of controller units, each controller unit connected to a one out of one or more switches, and one or more points of interworking for communication with fixed terminals, further comprising: a connection between a first unit of said plurality of controller units or said plurality of radio units and a second unit of said plurality of controller units or said plurality of radio units; means for detecting if a call is between a first terminal associated with said first unit and a second terminal associated with said second unit; and means for routing said call via said connection.

The connection can be permanent or deployed dynamically and may specifically be achieved through a second communication system.

According to a different aspect of the invention, there is provided a method of routing in a radio communication system with a plurality of radio units for communication with mobile terminals, each radio unit connected to one out of a plurality of controller units, each controller unit connected to one out of one or more switches, and one or more points of interworking for communication with fixed terminals, further comprising the steps of : establishing a connection between a first unit of said plurality of controller units or said plurality of radio units and a second unit of said plurality of controller units or said plurality of radio units; detecting if a call is between a first terminal associated with said first unit and a second terminal associated with said second unit; and routing said call via said connection.

Brief Description of the Drawings

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is an illustration of a radio communication system to which this invention applies.

FIG. 2 is an illustration of a radio communication system interconnecting network to which this invention applies.

FIG. 3 is an illustration of an example of local routing in a radio unit such as a central station.

FIGs. 4-7 illustrates four examples of a radio communication system modified in accordance with the present invention.

Detailed Description of a Preferred Embodiment

FIG. 1 illustrates a radio communication system 100 to which this invention is applicable. The example illustrated corresponds to the GSM cellular system. In the system, a central station 101 communicates with a number of mobile terminals 103 over radio channels 105. Specifically, the communication system can be a cellular system where the central station covers users within a certain geographical area 107 whereas other geographical areas 109,111 are covered by other central stations 113,115.

FIG. 2 illustrates an example of the interconnecting network 200 connecting the central stations. The example and the following description mainly considers a GSM communication system although the invention is by no way limited to such a system.

Referring to FIG. 2, a plurality of mobile terminals 201 communicate with a plurality of radio units 203 over radio channels 205. In GSM the radio units correspond to the central stations or Base Transceiver Stations (BTS). Each radio unit 203 is connected to a controller unit 207 corresponding to a GSM Base Station Controller (BSC). Each controller unit 207 is connected to a switch 209 corresponding to the Mobile Switching Centres (MSC) of GSM. A number of switches can be connected together or the network can contain only one switch.

During a call between mobile terminals, data from the mobile terminal 201 is routed from the radio unit 203 through the controller unit 207 to the switch 209 where it is either routed to the appropriate switch 209 or controller unit 207. This is very inefficient routing when the call is for example between two mobile terminals 201 associated with the same radio unit 203. An earlier British patent application (no. 9616794.5) teaches a local routing to be applied in the radio unit 203 carrying a call between two mobile terminals 201 of the same radio unit 203. As illustrated in FIG. 3, this local routing forms a data path 301 between the two mobile terminals 201 not including the controller unit 207 or the switch 209. This improves the efficiency of the routing for calls between mobile terminals 201 of the same radio unit 203 but not between mobile terminals 201 associated with different radio units 203.

For a call between a mobile terminal and a fixed terminal of the public fixed line telephone system, the data is typically routed from the radio unit 203 to the switch 209 where a point of interworking connects the two systems.

According to the present invention there is provided a radio communication system as described but furthermore comprising at least one additional connection, means for detecting that a call can be routed along this connection and means for routing the call through the connection. For example, a connection 401 can be established between a first controller unit 403 and a second controller unit 405 as illustrated in FIG. 4. Normally, a call from a mobile terminal 407 associated with the first controller unit 403 and a second mobile terminal 409 associated with the second controller unit 405 would be routed through the switch 411. According to the invention the call can be routed directly from the first controller unit 403 to the second controller unit 405 through the connection 401 thereby reducing the data flow on the connections 413, 415 between the controller units 403, 405 and the switch 411.

The connection can alternatively be between two radio units 203 or between a radio unit 203 and a controller unit 207, 403, 405. As an example, referring to FIG. 5, a connection could be established between a first radio unit 501 and a second radio unit 503 through the associated controller unit 505, the connection 507 thus being formed by the two links 509, 511 between the radio units 501,503 and the controller unit 505 and an internal switching performed in the controller unit 505. This connection can be achieved simply by changing the switching performed in the controller unit 505 and does not require a new physical link to be created between the radio units 501, 503.

The invention is not limited to one connection or to one type of connection, and any number and combination of connections may be applied. Furthermore, the connection is not limited to being between radio units and controller units associated with the same switch 515 but can be between units related to separate switches 517.

According to the invention the routing through the connection is not necessarily limited to terminals associated with the units between which the additional connection has been set up. For example, referring to FIG. 6, a connection can exist between two radio units 609, 611 and be used for routing a call between two mobile terminals 603, 617 not associated with either of these radio units. In the example shown, a data path 601 is formed from the radio unit 605 associated with the first mobile terminal 603 through a common controller unit 607 to the radio unit 609. From the radio unit 609 the path continues along the connection to radio unit 611, on to the controller unit 613 common with the radio unit 615 associated with the second mobile terminal 617.

The connection between two units can be implemented in many ways and any method known may be applied without detracting from the present invention. One alternative is a leased line directly set up between two units. For example, if the traffic distribution of the communication system is such that a high amount of data is transferred between the two controller units 403 and 405 it may be cost efficient to lease a line directly connecting these controller units and route the data through this line.

However, many large organisations and companies use a Private Branch eXchange (PBX) to which the fixed terminals are connected. This allows calls within the company to be routed locally between the terminals without requiring the public fixed line telephone system to be used. Additionally, a radio unit or possibly a controller unit can be connected to the PBX extending the benefits of a local PBX to the mobile terminals. In some cases a direct connection between different PBXs is set up. For example, a large company operating from two different sites will typically have a PBX at each site and a direct connection between the two PBXs. This allows not only calls within each site but also calls between the two sites to avoid using the public fixed line telephone system. Preferably, the connection between units according to the current invention is set up through a direct line between two or more PBXs.

FIG. 7 illustrates the example. Two radio units 701 and 707 are assumed to cover two different sites each with their own local PBX 703, 705. The two

PBXs are connected together by a direct leased line 709 carrying all internal calls from fixed terminals between the two sites. Additionally, the two radio units 701, 707 are connected to the two PBXs 703,705 and any call involving a mobile terminal in one of the sites communicating with a mobile or fixed terminal in the other site will be routed along the direct leased line 709. In the example of FIG. 7, the two radio units are associated with different controller units and different switches. In addition calls from a mobile terminal in one site communicating with a terminal not in the second site may also be routed through the direct leased line 709. For example, if the first site is in Europe and the second site is in America, a call between a mobile terminal in the first site can be routed to the PBX at the second site and through this PBX be connected to the American public fixed line telephone system. This is likely to incur fewer charges than a call from this mobile terminal to a subscriber of the public fixed line telephone system in America using the conventional routing.

When using a connection involving a PBX, the system will thus set up the connection by setting up a call on the PBX in a known manner. Preferably, this is done by the controller unit although a controller for routing can be situated anywhere in the system as described in the following paragraph. An embodiment involving local PBXs is likely to incur very little added cost as the direct connection of these often exist regardless of the radio communication system. However, the reduced cost of routing can be very substantial as especially the cost of routing between switches typically is very high.

The radio communication system would preferably comprise a controller responsible for determining the routing of data with reference to the current connection. Preferably, this controller will be supplied information on which connections are deployed or can be deployed in the interconnecting network. In the following description, it is assumed that the controller is placed in a switch 209 although it can be placed in a switch, a controller unit, a radio unit or be distributed in the system. Referring to FIG. 4, when the connection 401 is set up, this is communicated to the controller in the switch 411, preferably through a signalling channel on the connection 413 or 415 between the controller

units 403, 405 and the switch 411. The controller will have information on which radio units 203 are connected to which controller units 403, 405, 207. Preferably when a call is set up or a handover is performed, the controller will determine the destination address of the data relating to the call and determine if this corresponds to radio units where it will be advantageous to route through an alternative connection 401. If so, the controller will direct the controller units 403, 405 to route the call through the connection, again preferably using signalling channels on the existing connections 413, 415. If a handover occurs for any of the involved mobile terminals 407, 409, the controller will again evaluate if it is beneficial to route through the connection 401 or if routing should be through the switch 411.

The controller may route the call through the additional connection whenever possible or may only do so when it will result in for example a lower cost or possibly reducing the probability of blocking of one of the connections otherwise chosen.

The connection between two units can be deployed permanently or can dynamically be set up and removed. For example, a company operating from two distinct sites served by two different radio units is likely to have a high amount of communication between the two sites during a working day but possibly not outside working hours. In this case a connection can be set up at the beginning of a working day and removed at the end of the working day. The set up and removal of the connection can thus be predetermined or alternatively, the need for a connection can dynamically be evaluated and the connection deployed according to this. The determination of whether to set up a connection can be determined by the routing controller or a separate controller can be included. Preferably, the controller will contain a list of all possible connections which can be set up and will continuously monitor the traffic distribution in the system. When a high amount of traffic which can be routed through one of the optional connections is identified, the connection will be set up. If traffic changes so that the connection only carries little or no traffic, the connection can be removed again.

Implementation of the controllers will preferably be as a software program running on a suitable processor such as a micro processor or a digital signal processor. In the individual unit, the actual routing of the data between different connections can likewise be implemented by software control. However, many methods for and implementations of controllers for routing are known and any known technique may be applied without subtracting from the current invention.

The invention thus provides the possibility of a more efficient, flexible and cost efficient routing in a radio communication system by deploying and routing traffic through connections directly between units rather than requiring the routing to be via the master switch unit.

Claims

1. A radio communication system with a plurality of radio units for communication with mobile terminals, each radio unit connected to one out of a plurality of controller units, each controller unit connected to a one out of one or more switches, and one or more points of interworking for communication with fixed terminals, further comprising :

a connection between a first unit of said plurality of controller units or said plurality of radio units and a second unit of said plurality of controller units or said plurality of radio units;

means for detecting if a call is between a first terminal associated with said first unit and a second terminal associated with said second unit; and

means for routing said call via said connection.

2. A radio communication system as claimed in claim 1 wherein said first unit is a first controller unit and said second unit is a second controller unit.

3. A radio communication system as claimed in claim 1 wherein said first unit is a first radio unit and said second unit is a second radio unit.

4. A radio communication system as claimed in claim 3 with said connection being through a controller unit connected with both said first radio unit and said second radio unit.

5. A radio communication system as claimed in claim 1 wherein said first unit is a first controller unit and said second unit is a first radio unit.

6. A radio communication system as claimed in claim 3 or 5 wherein a call is routed through said connection between a terminal associated with a third radio unit connected to a second controller unit to which said first radio unit is also connected.

7. A radio communication system as claimed in claim 1 wherein switch said first unit and said second unit are associated with different switches.

8. A radio communication system as claimed in claim 1 wherein said connection is a direct leased line.

9. A radio communication system as claimed in claim 1 wherein said connection is set up through a private branch exchange.

10. A radio communication system as claimed in claim 1 wherein said connection is between a first private branch exchange connected with said first unit and a second private branch exchange connected with said second unit.

11. A radio communication system as claimed in claim 1 wherein said connection is through a second communication system.

12. A radio communication system as claimed in claim 11 wherein said second communication system is a fixed telephone system.

13. A radio communication system as claimed in claim 1 wherein the existence of said connection is communicated to a first controller responsible for routing said call.

14. A radio communication system as claimed in claim 13 said first controller comprising:

means for determining a destination address of data related to said call,

means for determining a list of destination addresses which can be reached through said connection, and

means for routing said call in response to said destination address and said list of destination addresses.

15. A radio communication system as claimed in claim 14 wherein said first controller resides in a first controller unit associated with said first unit.

16. A radio communication system as claimed in claim 14 wherein said first controller resides in second switch associated with said first unit.

17. A radio communication system as claimed in claim 1 wherein said connection is dynamically deployed.

18. A radio communication system as claimed in claim 17 further comprising:

means for evaluating a traffic distribution, and

means for deploying said connection in response to said traffic distribution.

19. A radio communication system as claimed in any of the claims 1, 4, 6, 10,11,12 or 14 wherein said radio communication system is characterised by being a GSM communication system.

20. A method of routing in a radio communication system with a plurality of radio units for communication with mobile terminals, each radio unit connected to one out of a plurality of controller units, each controller unit connected to one out of one or more switches, and one or more points of interworking for communication with fixed terminals, further comprising the steps of :

establishing a connection between a first unit of said plurality of controller units or said plurality of radio units and a second unit of said plurality of controller units or said plurality of radio units;

detecting if a call is between a first terminal associated with said first unit and a second terminal associated with said second unit; and

routing said call via said connection.

21. A method as claimed in claim 20 wherein said connection is set up through a private branch exchange.

22. A method as claimed in claim 20 wherein said connection is between a first private branch exchange connected with said first unit and a second private branch exchange connected with said second unit .

23. A method as claimed in claim 20 wherein said connection is through a fixed telephone system.

24. A method as claimed in claim 20 further comprising the steps of:

determining a destination address of data related to said call,

determining a list of destination addresses which can be reached through said connection, and

routing said call in response to said destination address and said list of destination addresses.

25. A method as claimed in any of the claims 20 to 24 wherein said radio communication system is characterised by being a GSM communication system.

26. A radio communication system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

27. A method of routing in a radio communication system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

The Patent Office

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Application No:	GB 9802367.4	**Examiner:**	Nigel Hall
Claims searched:	all	**Date of search:**	12 August 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4L (LDTT, LDSY)

Int Cl (Ed.6): H04Q 7/22, 7/30

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,E	GB 2316272 A	(MOTOROLA)	1,20 at least
X	GB 2298997 A	(HITACHI) See p22 line 18-p23 line1	1,20 at least
X	GB 2288104 A	(GPT)	1,20 at least
X	GB 2245455 A	(STC)	1,20 at least
X	WO 95/24789 A2	(NOKIA)	1,20 at leasT
X	US 5533114	(BALLARD)	1,20 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.